MIC38HC42/3/4/5

BiCMOS 1A Current-Mode PWM Controllers

Features

- Fast 20 ns Output Rise and 15 ns Output Fall Times
- –40°C to +85°C Temperature Range Exceeds UC284x Specifications
- High-Performance, Low-Power BiCMOS Process
- Ultra-Low Start-Up Current (50 µA Typical)
- Low Operating Current (4 mA Typical)
- High Output Drive (1A Peak Current, HC Version)
- CMOS Outputs with Rail-to-Rail Swing
- Current-Mode Operation up to 500 kHz
- Trimmed 5V Bandgap Reference
- Pin-for-Pin Compatible with UC3842/3843/3844/3845(A)
- Trimmed Oscillator Discharge Current
- UVLO with Hysteresis
- Low Cross-Conduction Currents

Applications

- Current-Mode, Offline, Switched-Mode Power Supplies
- Current-Mode, DC-to-DC Converters
- Step-Down “Buck” Regulators
- Step-Up “Boost” Regulators
- Flyback, Isolated Regulators
- Forward Converters
- Synchronous FET Converters

General Description

The MIC38HC4x family are fixed-frequency current-mode PWM controllers with 1A drive current capability. Microchip’s BiCMOS devices are pin-compatible with 384x bipolar devices. Their high output drive, with fast rise and fall times, combined with low startup current make them ideal PWM controllers when high efficiency is required.

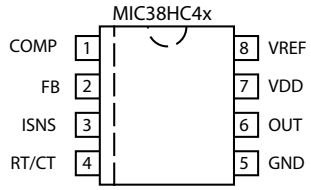
Undervoltage lockout circuitry allows the ’42 and ’44 versions to start up at 14.5V and operate down to 9V, and the ’43 and ’45 versions start at 8.4V with operation down to 7.6V. All versions operate up to 20V.

When compared to bipolar UC384x devices operating from a 15V supply, start-up current has been reduced to 50 µA typical and operating current has been reduced to 4.0 mA typical. Decreased output rise and fall times drive larger MOSFETs, and rail-to-rail output capability increases efficiency, especially at lower supply voltages. The MIC38HC4x also features a trimmed oscillator discharge current and bandgap reference.

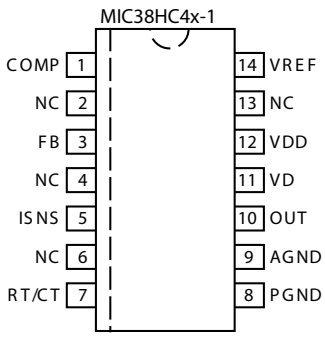
MIC38HC4x-1 is available in 14-lead plastic DIP and SOIC packages. 8-lead devices feature small size, while 14-lead devices separate the analog and power connections for improved performance and power dissipation.

Package Types

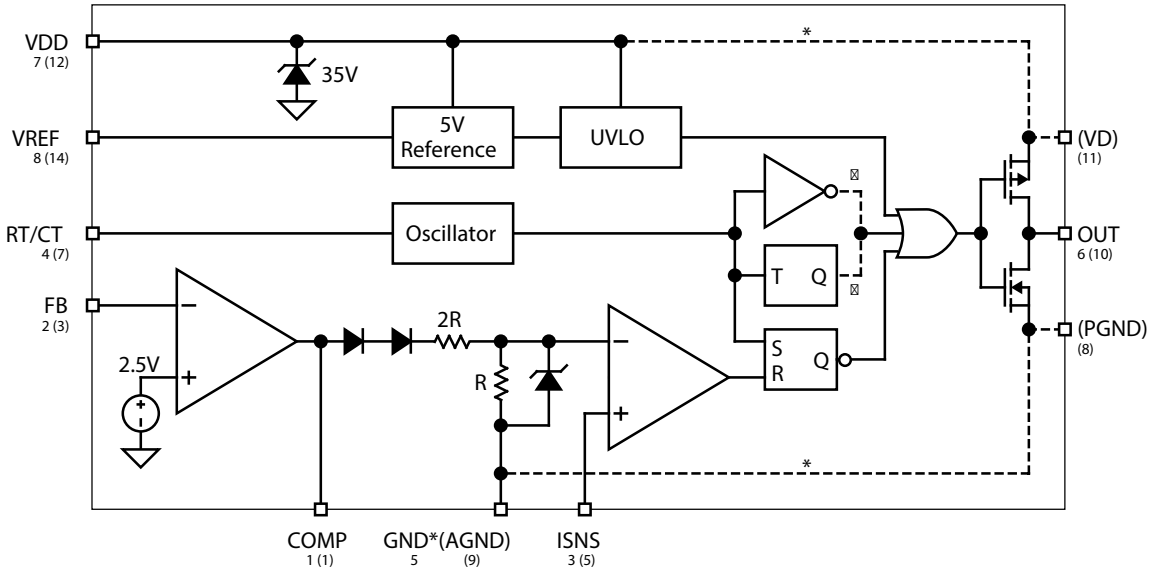
MIC38HC4x
8-Lead SOIC (M)
8-Lead PDIP (N)
(Top View)



MIC38HC4x-1
14-Lead SOIC (M)
14-Lead PDIP (N)
(Top View)



Functional Block Diagram



( ) pins are on MIC38HC4x-1 (14-lead) versions only
* MIC38HC4x (8-lead) versions only
⊠ MIC38HC42, MIC38HC43 (96% max. duty cycle) versions only
⊠ MIC38HC44, MIC38HC45 (50% max. duty cycle) versions only

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Zener Current (V_{DD}) ..... 30 mA

Operation at ≥18V may require special precautions (Note 1).

Supply Input Voltage (V_{DD}) (Note 1) ..... +20V

Switch Supply Voltage (V_D) ..... +20V

Current Sense Voltage (V_{ISNS}) ..... –0.3V to +5.5V

Feedback Voltage (V_{FB}) ..... –0.3V to +5.5V

Output Current (I_{OUT}) 1A

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Note 1: On 8-lead versions, 20V is the maximum input on Pin 7 because this is also the supply pin for the output stage. On 14-lead versions, 40V is the maximum for Pin 12 and 20V is the maximum for Pin 11.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{DD} = 15V, Note 1; R_T = 9.09 kΩ; C_T = 3.3 nF; –40°C ≤ T_A ≤ 85°C; unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Reference						
Output Voltage	V_{OUT}	4.90	5.00	5.10	V	T_A = 25°C, I_O = 1 mA
Line Regulation	$\Delta V_{OUT}/V_{OUT}$	—	2	20	mV	12V ≤ V_{DD} ≤ 18V, I_O = 5 µA, Note 2
Load Regulation	$\Delta V_{OUT}/(V_{OUT} \times \Delta V_{IN})$	—	1	25	mV	1 mA ≤ I_O ≤ 20 mA
Temperature Stability	T_{STAB}	—	0.2	—	mV/°C	Note 3
Total Output Variation		4.82	—	5.18	V	Line, Load, Temp., Note 3
Output Noise Voltage		—	50	—	µV	10Hz ≤ f ≤ 10 kHz, T_A = 25°C, Note 3
Long Term Stability		—	5	25	mV	T_A = 125°C, 1000 hrs., Note 3
Output Short Circuit		–30	–80	–180	mA	—
Oscillator						
Initial Accuracy		49	52	55	kHz	T_A = 25°C, Note 4
Voltage Stability	V_{STAB}	—	0.2	1.0	%	12V ≤ V_{DD} ≤ 18V, Note 2
Temperature Stability	T_{STAB}	—	0.04	—	%/°C	T_{MIN} ≤ T_A ≤ T_{MAX}, Note 3
Clock Ramp Reset Current	I_{CLK_RR}	7.7	8.4	9.0	mA	T_A = 25°C, $V_{RT/CT}$ = 2V
		7.2	8.4	9.5		T_A = T_{MIN} to T_{MAX}
Amplitude		—	1.9	—	V_{PP}	$V_{RT/CT}$ peak to peak
Error Amp						
Input Voltage	V_{IN}	2.42	2.50	2.58	V	V_{COMP} = 2.5V
Input Bias Current	I_{IN}	—	–0.1	–2	µA	V_{FB} = 5.0V
Voltage Amplitude	A_{VOL}	65	90	—	dB	2V ≤ V_O ≤ 4V
Unity Gain Bandwidth		0.7	1.0	—	MHz	Note 3
Power Supply Rejection Ratio	PSRR	60	—	—	dB	12V ≤ V_{DD} ≤ 18V
Output Sink Current	I_{SINK}	2	14	—	mA	V_{FB} = 2.7V, V_{COMP} = 1.1V
Output Source Current	I_{SOURCE}	–0.5	–1	—	mA	V_{FB} = 2.3V, V_{COMP} = 5V
Output Voltage High	V_{OH}	5	6.8	—	V	V_{FB} = 2.3V, R_L = 15 kΩ to Ground

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: V_{DD} = 15V, Note 1; R_T = 9.09 kΩ; C_T = 3.3 nF; –40°C ≤ T_A ≤ 85°C; unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Low	V_{OL}	—	0.1	1.1	V	V_{FB} = 2.7V, R_L = 15 kΩ to V_{REF}
Current Sense						
Gain		2.85	3.0	3.15	V/V	Note 5, Note 6
Maximum Threshold		0.9	1	1.1	V	V_{COMP} = 5V, Note 5
Power Supply Rejection Ratio	PSRR	—	70	—	dB	12V ≤ V_{DD} ≤ 18V, Note 5
Input Bias Current		—	–0.1	–2	µA	—
Delay to Output Time	t_{D-O}	—	120	250	ns	—
Output						
$R_{DS(ON)}$ High		—	10	—	Ω	I_{SOURCE} = 200 mA
$R_{DS(ON)}$ Low		—	5.5	—	Ω	I_{SINK} = 200 mA
Rise Time	t_R	—	20	50	ns	T_A = 25°C, C_L = 1 nF
Fall Time	t_F	—	15	40	ns	T_A = 25°C, C_L = 1 nF
Undervoltage Lockout						
Start Threshold Voltage	V_{ST_TH}	13.5	14.5	15.5	V	MIC38HC42/4
		7.8	8.4	9.0		MIC38HC43/5
Minimum Operating Voltage	$V_{OP(MIN)}$	8	9	10	V	MIC38HC42/4
		7.0	7.6	8.2		MIC38HC43/5
Pulse Width Modulator						
Maximum Duty Cycle	D_{MAX}	94	96	—	%	MIC38HC42/3
		46	50	—		MIC38HC44/5
Minimum Duty Cycle	D_{MIN}	—	—	0	%	—
Total Standby Current						
Start-Up Current	I_{SU}	—	50	200	µA	V_{DD} = 13V, MIC38HC42/44
		—	50	200		V_{DD} = 7.5V, MIC38HC43/45
Operating Supply Current		—	4.0	6.0	mA	V_{FB} = V_{ISNS} = 0V
Zener Voltage	V_{DD}	30	37	—	V	I_{DD} = 25 mA, Note 2

Note 1: Adjust V_{DD} above the start threshold before setting at 15V.

2: On 8-lead versions, 20V is the maximum input on Pin 7 because this is also the supply pin for the output stage. On 14-lead versions, 40V is the maximum for Pin 12 and 20V is the maximum for Pin 11.

3: These parameters, although ensured, are not 100% tested in production.

4: Output frequency equals oscillator frequency for the MIC38HC42 and MIC38HC43. Output frequency for the MIC38HC44 and MIC38HC45 equals one half the oscillator frequency.

5: Parameter measured at trip point of latch with V_{EA} = 0V.

6: Gain is defined as A = $\Delta V_{PIN1}/V_{TH}$ x I_{SNS}; 0 ≤ (V_{TH} x I_{SNS}) ≤ 0.8V.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Maximum Junction Temperature	$T_{J(MAX)}$	—	—	+150	°C	—
Junction Temperature Range	T_J	–40	—	+85	°C	—
Storage Temperature	T_S	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, PDIP 8-Ld	θ_{JA}	—	125	—	°C/W	—
Thermal Resistance, SOIC 8-Ld	θ_{JA}	—	170	—	°C/W	—
Thermal Resistance, PDIP 14-Ld	θ_{JA}	—	90	—	°C/W	—
Thermal Resistance, SOIC 14-Ld	θ_{JA}	—	145	—	°C/W	—

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

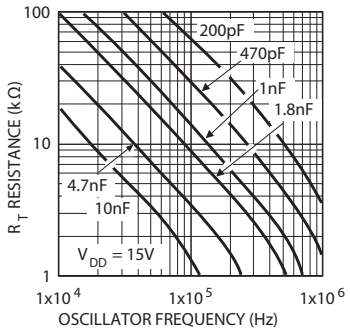


FIGURE 2-1: *Oscillator Frequency Configuration.*

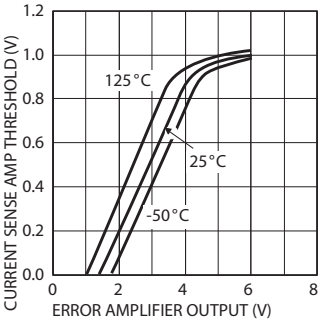


FIGURE 2-4: *Current Sense Amplifier vs. Error Amplifier Output.*

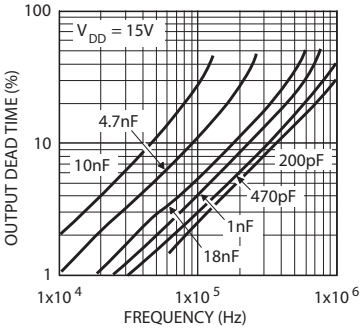


FIGURE 2-2: *MIC38HC42/3 Output Dead Time vs. Oscillator Frequency.*

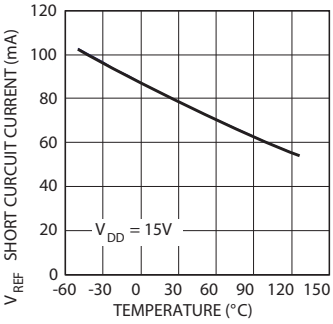


FIGURE 2-5: *Short-Circuit Reference Current vs. Temperature.*

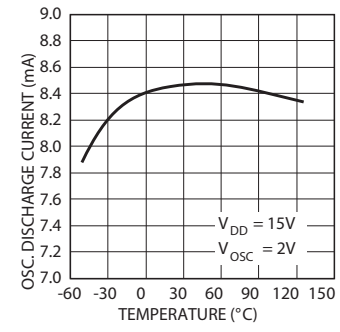


FIGURE 2-3: *Oscillator Discharge Current vs. Temperature.*

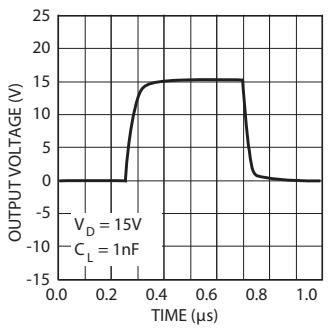


FIGURE 2-6: *MIC38HC4x Output Waveform.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

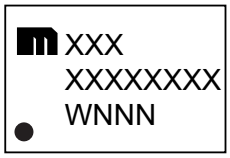
TABLE 3-1: PIN FUNCTION TABLE

Pin Number MIC38HC4x	Pin Number MIC38HC4x-1	Pin Name	Description
1	1	COMP	Compensation: Connect external compensation network to modify the error amplifier output.
—	2	NC	Not internally connected.
2	3	FB	Feedback (Input): Error amplifier input. Feedback is 2.5V at desired output voltage.
—	4	NC	Not internally connected.
3	5	ISNS	Current Sense (Input): Current sense comparator input. Connect to current sensing resistor or current transformer.
—	6	NC	Not internally connected.
4	7	RT/CT	Timing Resistor/Timing Capacitor: Connect external RC network to select switching frequency.
5	—	GND	Ground: Combined analog and power ground.
—	8	PGND	Power Ground: N-channel driver transistor ground.
—	9	AGND	Analog Ground: Controller circuitry ground.
6	10	OUT	Power Output: Totem-pole output.
—	11	VD	Power Supply (Input): P-channel driver transistor supply input. Return to power ground (PGND).
7	12	VDD	Analog Supply (Input): Controller circuitry supply input. Return to analog ground (AGND).
—	13	NC	Not internally connected.
8	14	VREF	5V Reference (Output): Connect external RC network.

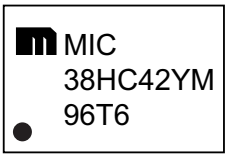
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

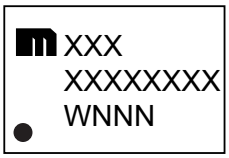
8-Lead SOIC*



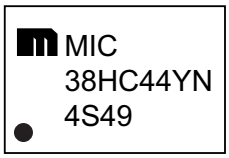
Example



8-Lead PDIP*

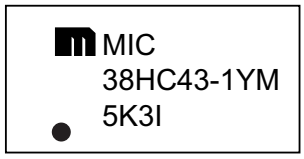


Example



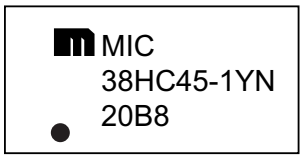
14-Lead SOIC*

Example



14-Lead PDIP*

Example



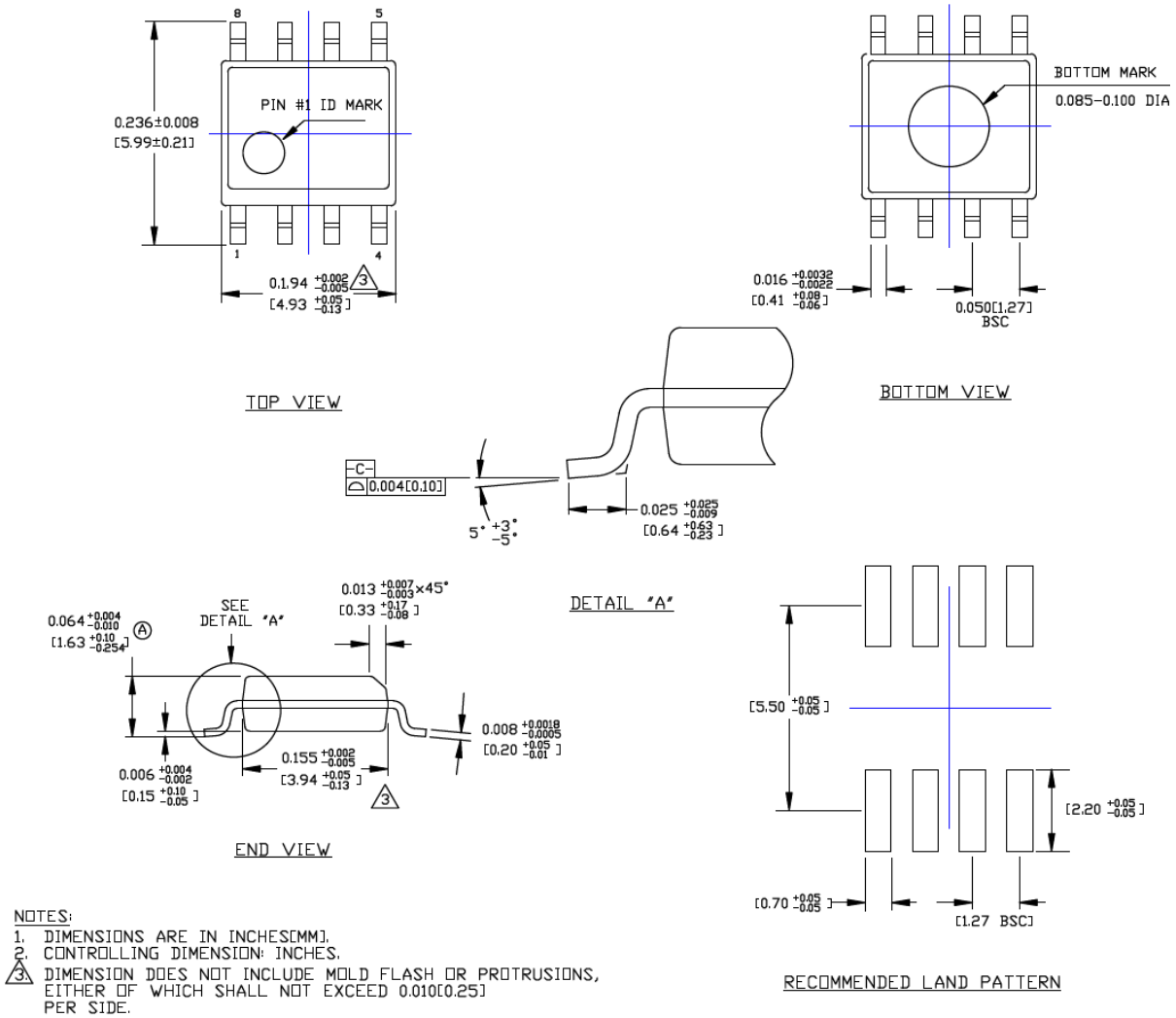
Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
Note:	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.	
	Underbar (_) symbol may not be to scale.	

Note: If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are used based on the available marking space:
6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN;
2 Characters = NN; 1 Character = N

8-Lead SOIC Package Outline and Recommended Land Pattern

TITLE
8 LEAD SOICN PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOICN-8LD-PL-1	UNIT	INCH [MM]



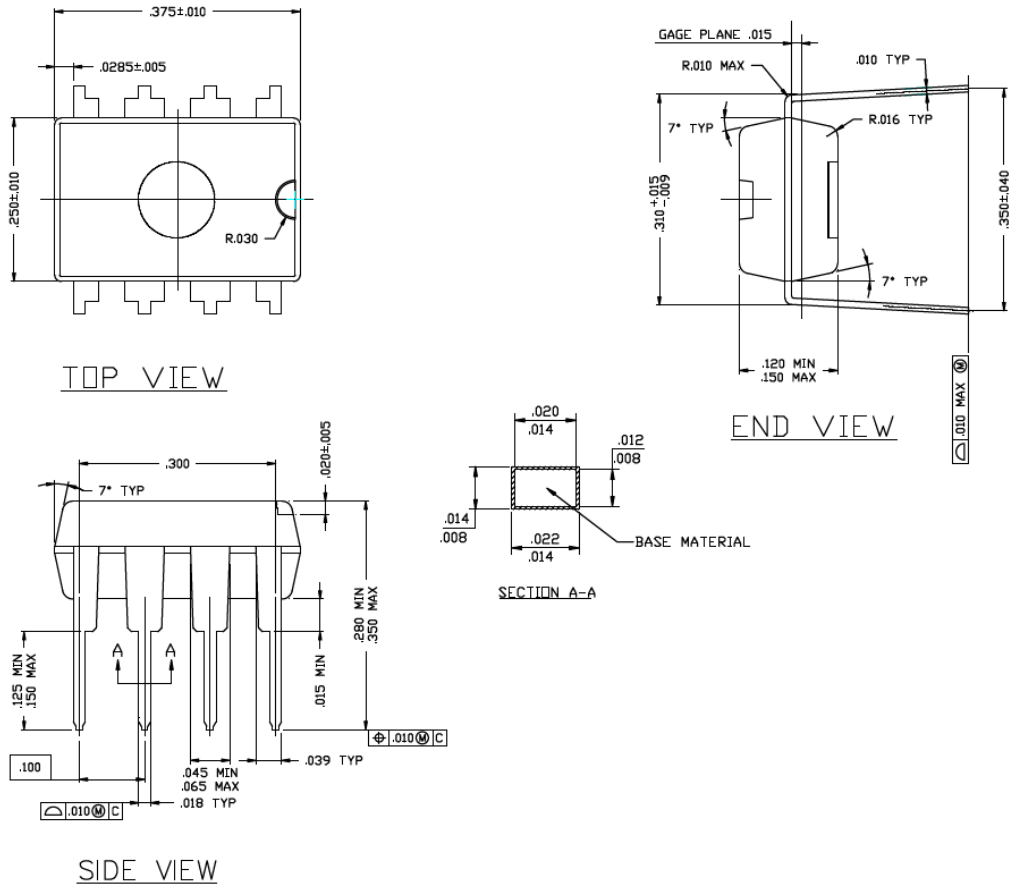
NOTES:
1. DIMENSIONS ARE IN INCHES[MM].
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.010[0.25] PER SIDE.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

8-Lead PDIP Package Outline and Recommended Land Pattern

TITLE
8 LEAD PDIP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	PDIP-8LD-PL-1	UNIT	INCH
Lead Frame	Copper	Lead Finish	Matte Tin

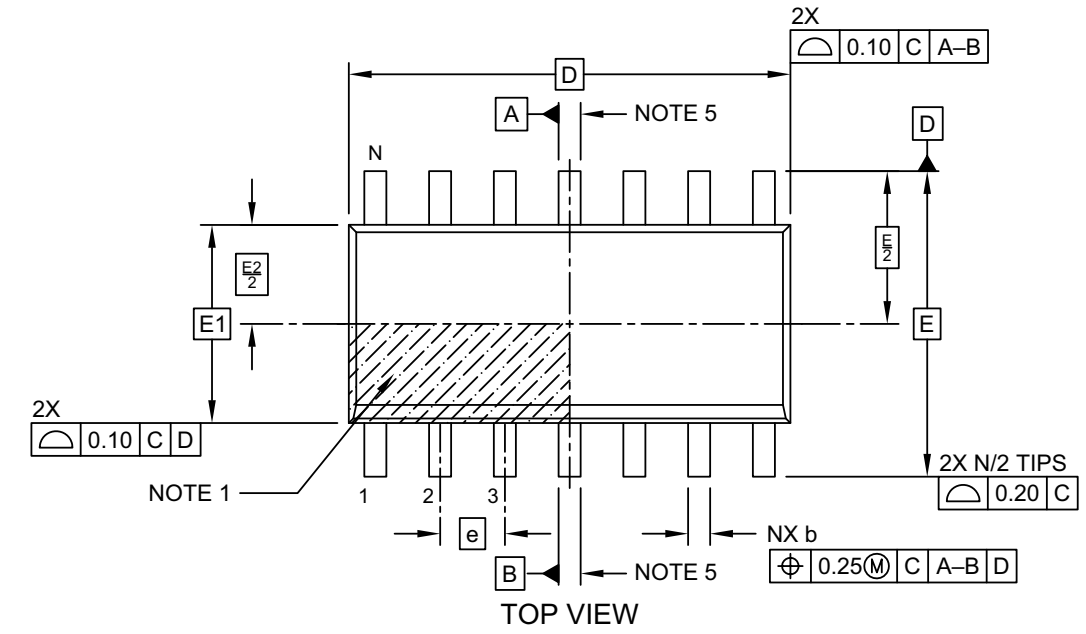


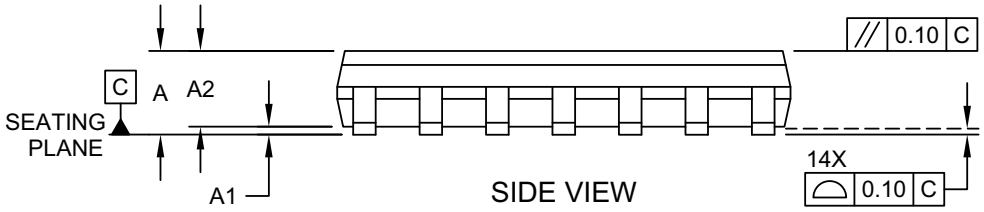
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

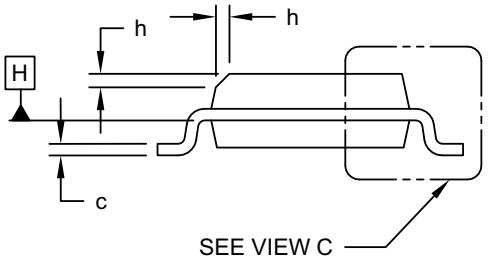
14-Lead SOIC Package Outline and Recommended Land Pattern

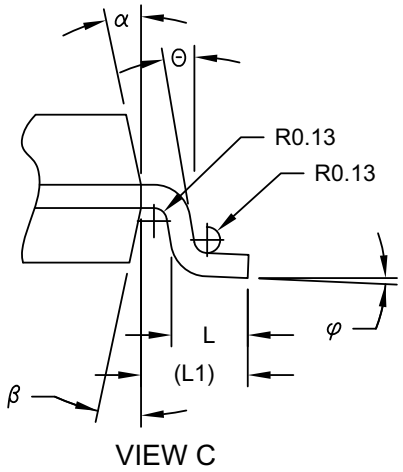
14-Lead Plastic Small Outline (D3X, UEB, M5B, UEB) - Narrow, 3.90 mm Body [SOIC] Atmel Legacy Global Package Code SVQ

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging





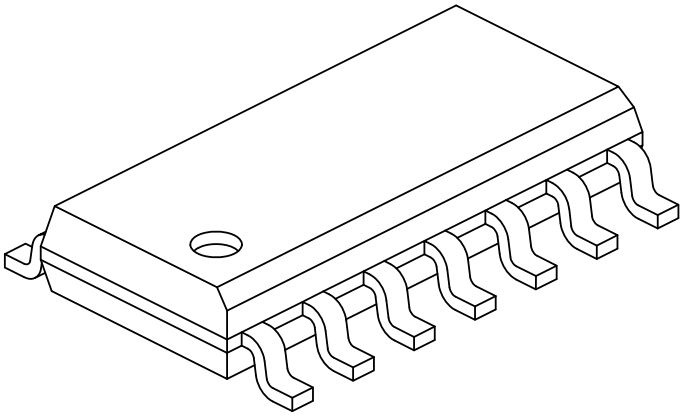




Microchip Technology Drawing No. C04-065-D3X Rev D

14-Lead Plastic Small Outline (D3X, UEB, M5B, UEB) - Narrow, 3.90 mm Body [SOIC]
Atmel Legacy Global Package Code SVQ

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	1.75
Molded Package Thickness	A2	1.25	-	-
Standoff §	A1	0.10	-	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Overall Length	D		8.65 BSC	
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1		1.04 REF	
Lead Angle	Θ	0°	-	-
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.10	-	0.25
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

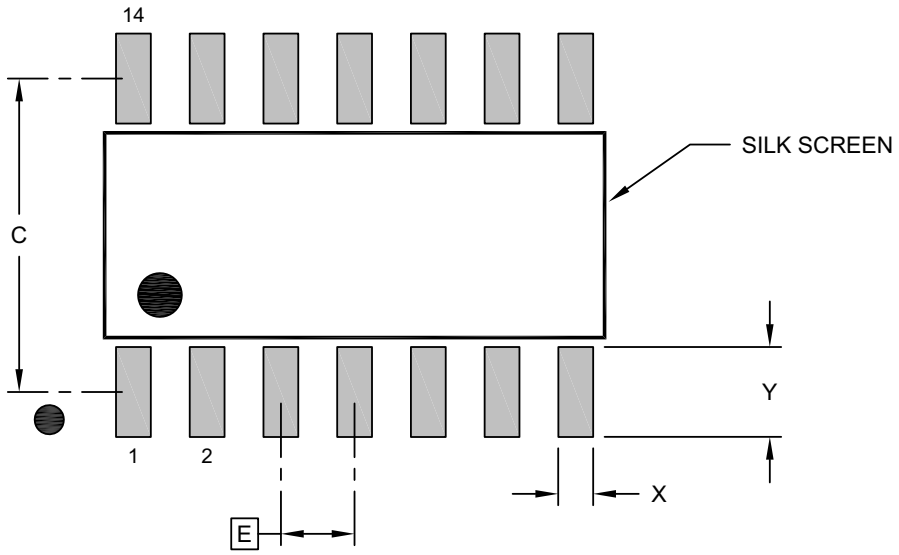
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-065-D3X Rev D Sheet 2 of 2

14-Lead Plastic Small Outline (D3X, UEB, M5B, UEB) - Narrow, 3.90 mm Body [SOIC]
Atmel Legacy Global Package Code SVQ

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Contact Pad Spacing	C		5.40	
Contact Pad Width (X14)	X			0.60
Contact Pad Length (X14)	Y			1.55

Notes:

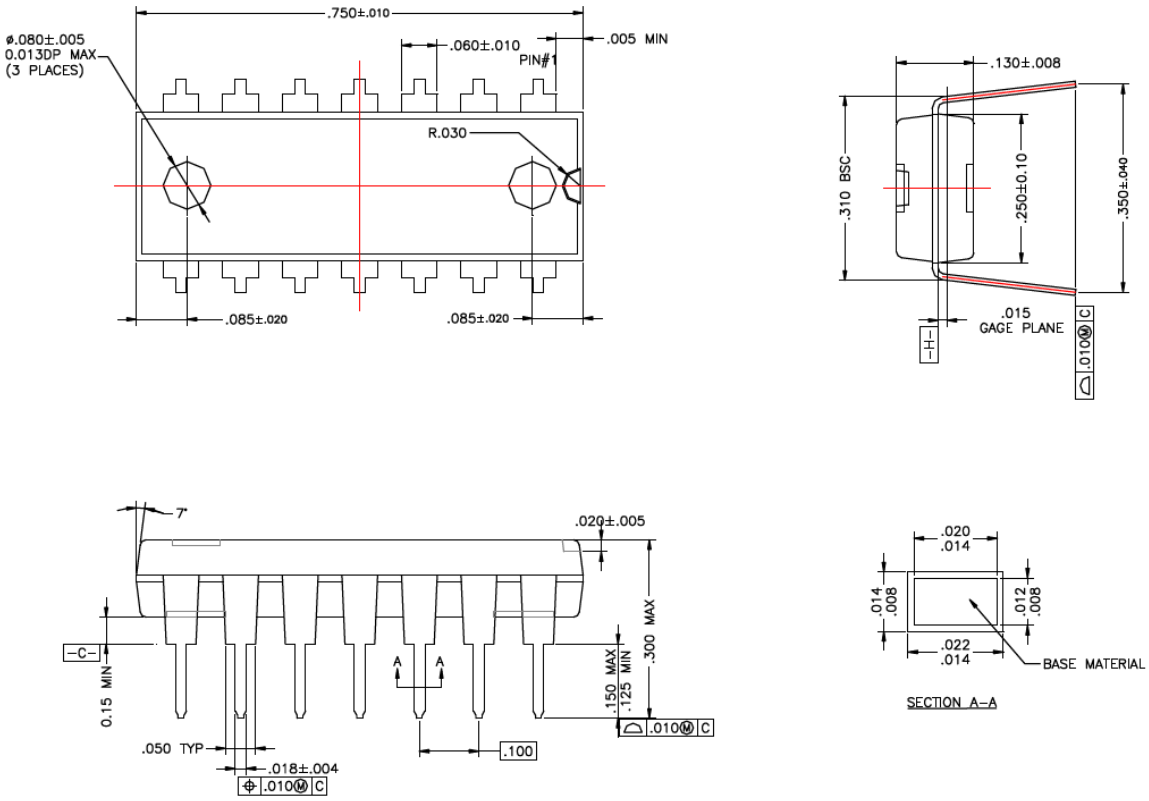
1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2065-D3X Rev D

14-Lead PDIP Package Outline and Recommended Land Pattern

TITLE
14 LEAD PDIP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	PDIP-14LD-PL-1	**UNIT**	INCH
LEAD FRAME	Copper	**LEAD FINISH**	Matte Tin



Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (March 2023)

- Converted Micrel document MIC38HC42/3/4/5 to Microchip data sheet DS20006735A.
- Minor text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Part Number	[-X]	X	X	[-XX]
Device	Special Package Option	Temp. Range	Package	Media Type

Device:	MIC38HC4x:	BiCMOS 1A Current-Mode PWM Controllers (see Selection Guide for specifics)
Special Package Option:	1 =	14-Lead PDIP or SOIC
Temperature Range:	Y =	–40°C to +85°C
Package:	M = N =	8-Lead or 14-Lead SOIC 8-Lead or 14-Lead PDIP
Media Type:	<blank>= <blank>= <blank>= <blank>= TR =	95/Tube (8-Lead SOIC only) 54/Tube (14-Lead SOIC only) 50/Tube (8-Lead PDIP only) 25/Tube (14-Lead PDIP only) 2,500/Reel (SOIC options only)

Examples:

a) MIC38HC42YM:	MIC38HC42 (see Selection Guide), –40°C to +85°C Temp. Range, 8-Lead SOIC, 95/Tube
b) MIC38HC43-1YN:	MIC38HC43 (see Selection Guide), –40°C to +85°C Temp. Range, 14-Lead PDIP, 25/Tube
c) MIC38HC44-1YM-TR:	MIC38HC44 (see Selection Guide), –40°C to +85°C Temp. Range, 14-Lead SOIC, 2,500/Reel
d) MIC38HC45YN:	MIC38HC45 (see Selection Guide), –40°C to +85°C Temp. Range, 8-Lead PDIP, 50/Tube
e) MIC38HC42-1YN:	MIC38HC42 (see Selection Guide), –40°C to +85°C Temp. Range, 14-Lead PDIP, 25/Tube
f) MIC38HC43YM-TR:	MIC38HC43 (see Selection Guide), –40°C to +85°C Temp. Range, 8-Lead SOIC, 2,500/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

Selection Guide

Duty Cycle	UVLO Thresholds	
	Startup 8.4V Minimum Operating 7.6V	**Startup 14.5V Minimum Operating 9V**
0% to 96%	MIC38HC43	MIC38HC42
0% to 50%	MIC38HC45	MIC38HC44

NOTES:

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